claims.

WHAT IS CLAIMED IS:

1. A magnetic sensor apparatus comprising:

a semiconductor substrate; and

a magnetic impedance device for detecting a magnetic field,

wherein the magnetic impedance device is disposed on the substrate.

2. The apparatus according to claim 1, further comprising:

a periphery circuit for processing an output signal outputted from the magnetic impedance device,

wherein the periphery circuit is disposed on the substrate.

3. The apparatus according to claim 2, further comprising:

a wiring layer made of aluminum material,

wherein the wiring layer connects to both ends of the magnetic impedance device, and

wherein the wiring layer has a pair of ends, which is disposed on a connection portion between the wiring layer and the magnetic impedance device.

4. The apparatus according to claim 3,

wherein each end of the wiring layer has a tapered shape.

5. The apparatus according to claim 3, further comprising:

a barrier metal film made of titanium material,

wherein the wiring layer connects to both ends of the magnetic impedance device through the barrier metal film.

6. The apparatus according to claim 3, further comprising:

a metallic film,

wherein the wiring layer connects to both ends of the magnetic impedance device through the metallic film.

7. The apparatus according to claim 6, further comprising:

an interlayer insulation film,

wherein the interlayer insulation film is disposed between the magnetic impedance device and the metallic film.

8. The apparatus according to claim 6,

wherein the metallic film is made of titanium material.

9. The apparatus according to claim 6,

wherein the metallic film is made of aluminum material, copper material, mixture of aluminum and titanium materials, or mixture of copper and titanium materials.

10. The apparatus according to claim 2,

wherein the magnetic impedance device is made of Ni-Fe series alloy.

11. The apparatus according to claim 2, further comprising:

a stress relaxation layer disposed between the substrate and the magnetic impedance device,

wherein the stress relaxation layer reduces a stress generated in the substrate in a case where the apparatus is processed in a

heat treatment.

12. The apparatus according to claim 11,

wherein the stress relaxation layer is made of poly-imide.

13. The apparatus according to claim 2, further comprising:

an oxidation protection film disposed on the magnetic impedance device.

14. The apparatus according to claim 13,

wherein the oxidation protection film is made of silicon oxides, silicon nitrides, or composite film of silicon oxides and silicon nitrides.

15. A method for manufacturing the magnetic sensor apparatus according to claim 1, the method comprising the steps of:

forming a stress relaxation layer on the substrate; and

forming the magnetic impedance device on the stress relaxation layer,

wherein the stress relaxation layer reduces a stress generated in the substrate in a case where the apparatus is processed in a heat treatment.

16. The method according to claim 15,

wherein the stress relaxation layer is made of poly-imide.

17. The method according to claim 15, further comprising the

steps of:

forming an oxidation protection film on the magnetic impedance device.

18. The method according to claim 17,

wherein the oxidation protection film is made of silicon oxides, silicon nitrides, or composite film of silicon oxides and silicon nitrides.

19. The apparatus according to claim 1,

wherein the magnetic impedance device detects a magnetic field in such a manner that impedance of the device is changed in accordance with the magnetic filed when an alternating current is applied to the device and the impedance is measured by an external electric circuit,

wherein the magnetic impedance device includes a magnetic layer made of Ni-Fe series alloy film,

wherein the magnetic layer has a length defined as L1 in an energization direction of the alternating current, a width defined as L2 in a perpendicular direction perpendicular to the energization direction, and a thickness of the magnetic layer defined as L3,

wherein the ratio of the length and the width is defined as α, i.e., α=L1/L2, and the ratio of the width and the thickness is defined as β, i.e., β=L2/L3,

wherein the ratio α is equal to or larger than 10, and the ratio β is in a range between 1 and 50, and

wherein the thickness L3 is equal to or larger than 5μm.

20. The apparatus according to claim 19,

wherein the Ni-Fe series alloy film has a composition such that a content of Ni in the Ni-Fe series alloy film is in a range between 65wt% and 90wt%, and/or a content of Fe in the Ni-Fe series alloy film is in a range between 10wt% and 35wt%.

21. The apparatus according to claim 19,

wherein the magnetic layer has a square shaped cross-section, which is disposed perpendicular to the energization direction of the alternating current applied to the magnetic layer, and

wherein the square shaped cross-section has one side and the other side, an angle of which is in a range between 60° and 120°.

22. The apparatus according to claim 19,

wherein the Ni-Fe series alloy film has a plurality of grains, dimensions of which are in a range between 1nm and 1μm.

23. The apparatus according to claim 19,

wherein the magnetic layer is disposed on the substrate with or without a buffer layer therebetween, and

wherein the substrate has a surface roughness, which is equal to or smaller than 1μm.

24. The apparatus according to claim 19,

wherein the magnetic layer has an axis of easy magnetization, which is substantially parallel to or perpendicular to the energization direction of the alternating current.

25. The apparatus according to claim 1,

wherein the magnetic impedance device detects a magnetic field in such a manner that impedance of the device is changed in accordance with the magnetic filed when an alternating current is applied to the device and the impedance is measured by an external electric circuit,

wherein the magnetic impedance device includes a magnetic layer made of Ni-Fe series alloy film,

wherein the magnetic layer has a length defined as L1 in an energization direction of the alternating current, a width defined as L2 in a perpendicular direction perpendicular to the energization direction, and a thickness of the magnetic layer defined as L3, and

wherein the length L1 is equal to or larger than 100 μm, the width L2 is in a range between 5 μm and 100 μm, the thickness L3 is equal to or larger than 0.3 μm.

26. The apparatus according to claim 25,

wherein the Ni-Fe series alloy film has a composition such that a content of Ni in the Ni-Fe series alloy film is in a range between 65wt% and 90wt%, and/or a content of Fe in the Ni-Fe series alloy film is in a range between 10wt% and 35wt%,

wherein the Ni-Fe series alloy film has a plurality of grains, dimensions of which are equal to or smaller than 100nm, and

wherein the substrate has a surface roughness, which is equal to or smaller than 1300nm.

27. The apparatus according to claim 19, further comprising:

a protection layer for covering the magnetic layer,

wherein the protection layer is made of electrically insulation material.

28. The apparatus according to claim 27,

wherein the protection layer has a compression stress as an internal stress, the compression stress being equal to or smaller than 500MPa.

29. The apparatus according to claim 27,

wherein the protection layer has a tensile stress as an internal stress, the tensile stress being equal to or smaller than 100MPa.

30. The apparatus according to claim 27,

wherein the protection layer has a thickness in a range between $0.2\mu m$ and $5\mu m$.

31. The apparatus according to claim 27,

wherein the protection layer is made of at least one of materials selected from the group consisting of silicon nitrides, aluminum nitrides, silicon oxides, phosphorized silicon oxides, and boron-doped silicon oxides.

32. The apparatus according to claim 27,

wherein the protection layer is made of a composite material having a plurality of insulation materials.

33. The apparatus according to claim 27,

wherein the protection layer has a laminated structure.

34. A rotation sensor apparatus comprising:

a rotation body for providing a periodic change of intensity of magnetic field disposed around the rotation body in accordance with rotation of the rotation body;

a magnetic sensor having a magnetic impedance device for detecting the periodic change of the intensity of magnetic field so as to detect the rotation of the rotation body; and

a separation shield for separating between the rotation body and the magnetic sensor,

wherein the magnetic sensor detects the rotation of the rotation body through the separation shield.

35. The apparatus according to claim 34,

wherein the separation shield is a casing for covering the rotation body, and

wherein the magnetic sensor detects the rotation of the rotation body disposed in the casing.

36. The apparatus according to claim 34,

wherein the rotation body is made of a magnetic material or a material including the magnetic material, and has a gearwheel shape.

37. The apparatus according to claim 36, further comprising:

another magnetic sensor,

wherein two magnetic sensors are arranged in parallel so as to separate by a half of pitch of the rotation body and symmetrically disposed around a rotation axis of the rotation body, and

wherein two magnetic sensors output signals, respectively, so that a differential output signal is obtained.

38. The apparatus according to claim 36,

wherein the rotation body is a gear connecting to a crankshaft of an engine of a vehicle, and

wherein the separation shield is an engine block of the vehicle.

39. The apparatus according to claim 36,

wherein the rotation body is a cam connecting to a camshaft of an engine of a vehicle, and

wherein the separation shield is an engine block of the vehicle.

40. The apparatus according to claim 34,

wherein the rotation body is a cylindrical magnet having a pair of N and S poles, which is alternately disposed on a circumferential periphery of the cylindrical magnet.

41. The apparatus according to claim 40, further comprising:

another magnetic sensor,

wherein two magnetic sensors are arranged in parallel so as

to separate by a half of pitch of the rotation body and symmetrically disposed around a rotation axis of the rotation body, and

wherein two magnetic sensors output signals, respectively, so that a differential output signal is obtained.

42. The apparatus according to claim 40,

wherein the rotation body is a magnetized rotor mounted on a rotation shaft of a wheel of a vehicle, and

wherein the separation shield is a wheel hub of the vehicle.

43. The apparatus according to claim 34,

wherein the separation shield is made of non-magnetic material.

44. The apparatus according to claim 34,

wherein the separation shield is a sensor casing for covering the magnetic sensor,

wherein the sensor casing is made of magnetic material and includes an opening, which faces the rotation body, and

wherein the magnetic sensor detects the rotation of the rotation body through the opening of the sensor casing.

45. The apparatus according to claim 44,

wherein the sensor casing is made of a permanent magnet.

46. The apparatus according to claim 45,

wherein the sensor casing has both ends thereof, which open

for an outside of the sensor casing,

wherein the sensor casing has a sidewall for providing the permanent magnet, and

wherein the magnet sensor is disposed in the sensor casing.

47. The apparatus according to claim 44,

wherein the rotation body is made of magnetic material or a material including the magnetic material, and has a gearwheel shape.

48. The apparatus according to claim 47,

wherein the rotation body is a gear connecting to a crankshaft of an engine of a vehicle.

49. The apparatus according to claim 44,

wherein the rotation body is a cam connecting to a camshaft of an engine of a vehicle, and

wherein the cam is made of a magnetic material or a material including the magnetic material.

50. The apparatus according to claim 44,

wherein the rotation body is a cylindrical magnet having a pair of N and S poles, which is alternately disposed on a circumferential periphery of the cylindrical magnet.

51. The apparatus according to claim 44,

wherein the rotation body is a magnetized rotor mounted on a rotation shaft of a wheel of a vehicle.

52. The apparatus according to claim 34,

wherein the magnetic impedance device detects a magnetic field in such a manner that impedance of the device is changed in accordance with the magnetic filed when an alternating current is applied to the device and the impedance is measured by an external electric circuit,

wherein the magnetic impedance device includes a magnetic layer made of Ni-Fe series alloy film,

wherein the magnetic layer has a length defined as L1 in an energization direction of the alternating current, a width defined as L2 in a perpendicular direction perpendicular to the energization direction, and a thickness of the magnetic layer defined as L3,

wherein the ratio of the length and the width is defined as α, i.e., α=L1/L2, and the ratio of the width and the thickness is defined as β, i.e., β=L2/L3,

wherein the ratio α is equal to or larger than 10, and the ratio β is in a range between 1 and 50, and

wherein the width L3 is equal to or larger than 5μm.

53. The apparatus according to claim 34,

wherein the magnetic impedance device detects a magnetic field in such a manner that impedance of the device is changed in accordance with the magnetic filed when an alternating current is applied to the device and the impedance is measured by an external electric circuit,

wherein the magnetic impedance device includes a magnetic layer made of Ni-Fe series alloy film,

wherein the magnetic layer has a length defined as L1 in an energization direction of the alternating current, a width defined as L2 in a perpendicular direction perpendicular to the energization direction, and a thickness of the magnetic layer defined as L3, and

wherein the length L1 is equal to or larger than 100 μm, the width L2 is in a range between 5 μm and 100 μm, the thickness L3 is equal to or larger than 0.3 μm.

54. The apparatus according to claim 53,

wherein the Ni-Fe series alloy film has a composition such that a content of Ni in the Ni-Fe series alloy film is in a range between 65wt% and 90wt%, and/or a content of Fe in the Ni-Fe series alloy film is in a range between 10wt% and 35wt%,

wherein the Ni-Fe series alloy film has a plurality of grains, dimensions of which are equal to or smaller than 100nm, and

wherein the substrate has a surface roughness, which is equal to or smaller than 1300nm.